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PROCESS TANK AND METHOD FOR NON-VIGOROUS PROCESSING OF ORGANIC MATERIAL

The present invention relates to a process tank for gentle treatment of organic material, especially intended for treatment of organic material like fish waste, crab, krill or plant materials. The invention also relates to a method for processing organic material.

Background

In a process environment such as the fish processing industry there is a need to treat the raw material in an effective yet gentle way so that a highest possible yield, but still a very clean product, is achieved.

With the use of an ordinary stirring assembly, e.g consisting of an anchor stirrer or the like, a part of the material which should be recovered will be crushed and will be lost with the process water. Furthermore, the extraction fluid will be contaminated with particles from the residue. Another disadvantages is that a part of the extraction fluid is held back with the residue, giving a loss compared to the theoretical yield.

There are many practical applications of such process tanks, for instance the removal waste from the fish processing industry, processing of krill on board a trawler etc. An example from another area is the extraction of eteric oils from plant materials.

Objective

It is thus an objective with the present invention to provide a new and improved procss tank which eliminates or significantly reduces the disadvantages mentioned above, and which facilitates an effective and yet gentle treatment of organic material, in which a higher yield of extracted material than previously obtainable can be achieved, without jeopardizing the quality of the product.

It is a further objective to provide a process tank which, to a high degree, is adapted for an industrial operation, where modification may be made to allow for automatic controlling etc, so that the overall economy of the processes is high.

The invention

These and other objectives are achieved with a process tank for gentle treatment of its contents, especially intended for treatment of organic material, including means for agitation and characterized in that the process tank is a double tank comprising an inner tank with perforated wall areas which are rotatably supported with bearings in an outer tank with a substantially vertical axis of rotation, the perforated areas of the inner tank being provided with gratings and shovels being arranged slantingly in the space between the inner and the outer tank, said shovels, during rotation of the inner tank contribute to the agitation of the fluid in the tank, and a lid arranged to be raised and lowered on top of the inner tank, said lid preferably is provided with gratings.

The invention also concerns a method for processing organic material such as fish waste, crab shells, krill or plant material in which a gentle agitation of the material is preferred, by introducing the material into a process tank together with a controlled amount of processing liquid and subjecting the material to a process under *per se* known conditions, the method being characterized by the following steps,

utilizing a double process tank which comprises an inner tank with perforated wall areas with gratings, said inner tank being rotatably supported with bearings in an outer tank with a generally vertical axis of rotation,

choosing gratings with a mesh size such that the entire solid material is retained in the inner tank,

controlling process parameters like temperature and pH according to the nature of the relevant process,

agitating the process liquid by allowing the inner tank to rotate relative to the outer tank such that shovels between the inner and the outer tank facilitate a gentle agitation of the material, and

compressing the solid material at the end of the treatment by means of a rising and lowering lid on the inner tank prior to and during the draining of the processing fluid from the tank.

Preferred embodiments of the invention and the method are disclosed by the dependent claims.

In the following description further elaboration of various features of the invention is given by way of reference to a normal operation cycle illustrated by the enclosed drawings, where

Fig. 1 shows a vertical section through an embodiment of a tank according to the invention, in which some details lying outside the plane of the section are indicated by dotted lines,

Fig. 2a is a sideview of the inner tank of the the tank shown on fig 1, showing gratings and its suporting structure.

Fig. 2b is a sideview of the inner tank of the tank shown on fig. 1, where the gratings and the supporting structure is left out to emphasize other details,

Fig. 3 depicts the lid on the inner tank from above.

Figure 1 shows a double tank 1 according to the invention with a solid wall 2 in the outer tank and a perforated wall 3 in the inner tank, and common bearings 4, 5 for both tanks about a vertical axis R-R. The outer tank has a lid 6 and the inner tank has a preferably perforated lid 7, the lid 7 being arranged so that it can be lowered in relation to the tanks around a spline shaft 15. Both the lids 6, 7 are strengthened by means of "cavelles" 30. Under the tank is shown a ball plug valve 8 through which material may be pumped into the tank for treatment, and through which the resdiue may be removed subsequent to the treatment.

Between the inner wall 3 and the outer wall 2 shovels 9 are indicated, some of which are attached to the inside of the outer wall 2, some of which are attached to the outside of the inner wall 3, so that a cooperation between these provides an agitation of the fluid in the tank when the inner tank rotates. Impellers 10 are shown at the bottom of the inner tank, the size and configuration of which will determine its contribution to a further agitation of the tank contents. For some applications it may also be appropriate to include a scraping shovel as indicated by reference numeral 11 on fig. 1. A supply conduit 12 for rinsing water is shown at the top of the tank as is a conduit 13 for the supply e.g. of nitrogen (N_2) at the bottom of the tank. Also illustrated in Fig. 1 is 5 a throttle valve 14 for draining of extraction fluid located upon the bottom of the tank.

Figures 2a and 2b show views of the inner tank, where several of the details from figure 1 are found, such as inner wall 3, rotation axis R-R, lid 7, shovel 9 (the ones fixed to the outside of the inner tank), impeller 10 at the supporting structure 17 of the inner tank, as well as gratings 18 at the open areas of the tank wall. A helically shaped groove 19 for guidance of the lid 7 during its lowering and raising movement is also indicated, said guidance groove 19 being arranged upon the inside of the tank wall 3. Guidance groove 19 functions as a "thread" for lid 7. At the top of the tank is a manhole which is sealed by a water- and airtight lid most of the time. Dotted lines L_t and L_b indicate the uppermost and the lowermost position of the lid 7. Figure 2b also shows castors 23 arranged to cooperate with the guide grooves 19 during lowering and raising of the lid.

Figure 3 shows the lid 7 with perforated areas 20 covered by gratings, distribution tubes 21 and rubber hoses 22 (four shown on the drawing) for washing liquid to the ejector tube 24 being supplied through the supply conduit 12 (fig. 1) through a particular device at the centre of the lid. An arrow to the left of fig. 3 indicates the rotational direction for normal operation. The drawing also illustrates the branching of the distribution tubes 21 which run along the carrier arms 25 from the axis where the distributions tubes 21 are connected to chemical resistant rubber tubes 22 or the like which in turn run from the supply tubes 21 to the ejector tube 24 along the circumference of the lid. These (rubber hoses) will not be exposed to particularly heavy wear as there will only be a downwards movement proportinally to the rotation when the lid is lowered.

The gratings 18 can be interchanged to ones with desired mesh size according to the kind of material which is treated. The agitation in the tank is effected by rotating the inner tank so that an agitation effect between the outer tank and the inner tank is obtained by means of the shovels 9, and optionally by means of impellers 10 at the bottom of the inner tank. In a preferred embodiment of the invention, the impellers 10 at the bottom of the inner tank is designed in a manner that enables them to force liquid from the centre of the tank outwards to the wall, while the shovels between the inner and the outer tank are so designed that they lift the liquid upwards in the region between the two walls. The overall effect is a generally downward movement of the liquid in the central region of the tank, and an effective, yet gentle agitation. The impellers 10 may

be inside the inner tank as shown on the drawing, or they may be outside the inner tank or partly inside, partly outside the inner tank.

To allow for a maximum movement of the liquid, it is beneficial that substantial areas of the inner tank are perforated and covered with gratings, and that the supporting structure only is sufficient to provide the tank with its necessary strength and rigidness. It is thus preferred that also the lid 7 of the inner tank is perforated and provided with gratings 18. The inner lid is arranged so that it can be lowered down into the inner tank. This is most easily done by arranging it with a central bushing 29 (fig. 2b) over a spline shaft 15 or the like, so that the lowering is simply effected by a slowing of the spline shaft 15 relative to the rotation of the inner tank, e.g. performed by means of an hydraulic braking arrangement. Outer guidance grooves 19 on the inside wall of the inner tank ensures that the lid is all the time held in a level position relative to the tank during this operation. For maximum versatility, it is beneficial to provide the lid 7 with some kind of castors 23 which roll along these guidance grooves 19 when the lid is moving up or down. The guidance grooves 19 are in a preferred embodiment designed such that the lid 7 rotates half a turn in relation to the inner tank when moving from its top position to its bottom position. The ascend angle of the guidance grooves should not exceed about 27°.

It is also prferred, as shown on figure 3, to provide an ejector tube 24 to the inside of the lid 7, said ejector tube comprising a series of nozzle openings. The purpose of this arrangement is to wash/ shower the wall of the inner tank while the lid 7 is being lowered, so that the entire residue is collected at the bottom of the inner tank, and ensuring that the downward movement of the inner tank is not hindered by remaining solid material which can stick to the gratings 18 or to the guidance grooves 19. This will also prevent solids remaining from ending up on top of the lid 7 when it is lowered. The supply of liquid is most conveniently performed through a bore in the central shaft. The rinsing liquid is normally taken from the process tank by means of a pump.

The most important objective with the feature of lowering the lid 7 is to facilitate a controlled compression of the raw material/ residue in the tank prior to the draining of the extraction liquid, so that as little as possible of the extracion liquid is held back. This further prevents the residue from acting like a filter which will hold back some of the material which is desired to be transferred with the extraction liquid. By holding the

material steady, the tank is also stabilized so that its rotational speed can be increased, which leads to an improved centrifugation of the residue.

The most practical way to attach the inner tank is at its upper end by means of carrier arms 25 which in turn are connected to the pinion shaft. The lid 7 can be attached by a so-called spline-bushing 29 to the spline shaft 15. The outer lid is strengthened with "cavelles" 30 and attached water and airtight to the outer tank, preferably with bolts.

By another preferred embodiment of the invention, a scraping shovel 11 is provided in the centre of the inner tank, which preferably is mounted on a shaft 27 led through the centre of the spline shaft 15, which is designed with a central bore with dimension to accomodate said shaft 27 for the scraping shovel 11. The function of the scraping shovel is to remove material from the inlet / outlet opening 8 centrally at the bottom of the tank. There is no need for automatic controlling of the scraping shovel as it will only be operated when needed.

At the start-up of a typical process, raw material is pumped into the inner tank through the ball plug valve 8. The outlet for the extraction liquid is close to the inlet opening for the raw material, and can have the form of a throttle valve. This is pumped to a separate tank for further treatment.

The simplest way for emptying the tank of solid material, includes filling the tank with liquid and allowing the tank to rotate in a direction opposite to the rotation of normal operation, while the lid is maintained in its upper position.

It is convenient to have the possibilty to supply gas to the tank. Most commonly inert gas is added to prevent oxidation of the raw material, but gases for special purposes, like additives can also be added if desired. For this purpose and according to the needs, one or more gas supplies may be provided.

Conveniently there is a drain in the lower part of the lower bearing so that the bearing can be drained before maintenance or replacement. The bearing may also be drained of any liquid during a longer stop of the tank or prior to change of extraction liquid.

Regarding the arrangement of the rotational axis R-R, it is evident that a certain deviation from a completely vertical arrangement in principle is possible, but it is inconvenient with respect to the strain thereby brought upon the tank and its bearings when the inner tank is set to rotate rapidly.

The rotational speed of the tank may vary within wide limits, but typically it will be set such that the absolute speed is in the range of 0.5 - 1 m/s at the periphery of the tank for an ordinary process. After completed processing, the residue is preferably centrifuged in order to remove as much as possible of the process liquid. During centrifugation the absolute speed at the periphery will typically be within 3.5 - 6 m/s.

A process tank according to the invention will normally contain a number of per se known devices for controlling process parameters, primary temperature and liquid level. Such devices can be quite simple electrical heaters, heat exchangers and/ or pipe arrangements for the addition of steam to the tank. For a typical application a steam loop 31 covering substantially the entire conical part of the bottom, with an inlet 32 arranged to the lower part of the outer tank just above the conical part. The outlet of condensate is arranged close to the bottom valve of the tank. The entire loop 32 is arranged so that it has a vertical distance of e.g. 10 cm from the conical bottom, which ensures a good contact between the steam loop and the extraction liquid. It is also possible to provide a steam jacket around the entire tank in order to heat it. In order to optimize energy the extraction liquid can be circulated through an external heat exchanger where condensate from the steam loop assists in heating the extraction liquid, or the extraction liquid can be preheated in a similar arrangement when supplied to the tank.

The construction of the inner tank may also be additionally strengthened so that the lid 7 may conduct a further compression of the material when the lid 7 is lowered.

The size of the tank may also be varied within wide limits and is actually only restricted by the needs of the actual applications.

In the following description some practical examples of the utilization of the tank are given.

Example 1

Ensilage of fish waste

Raw material consisting of fish waste from a fish processing plant is pumped into a tank according to the invention while the inner tank is already set to rotate. The raw material enters through the centre 8 of the bottom of the tank into the inner, perforated tank. Process water and blood water is separated from the raw material inside the tank and

pumped out through outlet 14. When the tank is suitably filled, water and acid are added to a desired concentration through a perforated supply tube 26 which follows the shovels 9 on the outer tank. The acid thus becomes evenly distributed from top to bottom. The tank is heated to appropriate temperature for effecting ensilation. During the process the lid 7 may be lowered if needed or desired. After completed ensilation, the lid 7 is lowered while the wall 3 of the inner tank is washed through the openings on the tube 24, whereafter the ensilage is pumped out through outlet 14 until the tank is empty of free liquid. Thereafter the rotational speed is increased and the remaining material is centrifuged of ensilage. When the subsequent remaining material is to be pumped out, the rotational direction of the inner tank is reversed and the lid 7 is raised to its top position. An appropriate amount of water is then pumped into the tank and the remaining material pumped out through valve 8 for subsequent treatment or depositing.

Example 2

Crab / lobster shells

Shells are crushed in a mill before being pumped into the tank through valve 8. When the inner tank is full, water is added and heated to desired temperature. An appropriate enzyme may also be added. Liquid additives like acids or bases are added through the supply tube 26 along the shovels 9 of the outer tank to a desired concentration. When the desired enzyme activity has taken place, the lid 7 is lowered and the resulting liquid is pumped out through the outlet 14 of the outer tank, the shells are centrifuged to remove as much as possible of the remaining liquid. The liquid can thereafter be processed further to e.g. taste substances. In the same manner as described in example 1, it is preferred to rinse the wall 3 of the inner tank while the lid is lowered.

The lid is raised to its top position and water is filled into the tank. When it is full, it is heated to desired temperature and acid is added to desired concentration. The shells are demineralised to chitin under controlled conditions wherein addition of acid is added subsequently along with the progress of the demineralisation. When the demineralisation is complete, the lid 7 is lowered with simultaneous washing of the wall 3 of the inner tank, and the tank is emptied of liquid through the outlet 14 of the outer tank. The residue material is then centrifuged. The lid is thereafter raised to its top position again and water is added for washing of the shells. The lid is again lowered and

the rinsing water is pumped out through the outlet 14 of the outer tank. When the chitin finally is pumped out, this process is handled as described by example 1, i.e.by filling the tank with water and rotating the inner tank in the reverse direction with open valve 8, draining the chitin out.

Example 3

Plant material for extraction of eteric oils

Relevant plants/ herbs are introduced to the tank in the form of a pumpable suspension through valve 8 or possibly through the manhole 20. Desired extraction liquid is added. The tank is heated to desired extraction temperature. During the extraction the lid 7 may be lowered if needed or desired. After extraction is performed the lid 7 is lowered and the extraction liquid pumped out through outlet 14. The resdiue material is centrifuged and compressed prior to a new extraction or prior to the draining of the material through valve 8.

Example 4

Krill

For this example it is convenient that the tank is placed onboard a krill trawler. When the krill is caught, the "flesh" is squeezed out in a normal manner. The krill waste is thereafter pumped into the tank through valve 8 and when the inner tank is full, the tank is filled preferably with seawater. The liquid is heated to desired temperature. An autolysis of the shells will now take place. When the autolysis is complete all the protein will be dissolved. The lid 7 is then lowered for compressing the shells under simultaneous washing of the wall 3 of the inner tank, whereafter the protein rich and oil inclusive liquid liquid be pumped out through outlet 14 possibly for subsequent treatment. The shells remaining in the tank are centrifuged to remove as much as possible of the protein rich oily liquid. Thereafter the tank is filled preferably with fresh water, the shells are washed and the procedure of pumping out repeated. When the tank has been emptied for rinsing water and the shells have been centrifuged, the tank is again filled with fresh water, acid is added to a desired concentration like in the preceding examples in order to demineralise the shells. The tank is heated to a desired temperature and acid concentration and temperature held constant during the entire

demineralisation process. When this process is completed, typically after 1 to 4 hours, the lid 7 is lowered so that it compresses the shells/ chitin and the mineral rich liquid is pumped out through the outlet 14 of the outer tank. When the tank has been emptied of liquid, the rotational direction is reversed and the lid is raised to its top position while water is filled onto the tank for washing of the chitin. The chitin is washed and compressed and the rinsing water pumped out through outlet 14. When all the (free) rinsing water has been removed, the chitin is centrifuged for remaining water.

Finally the tank is filled with water and the lid raised to its top position. The rotational direction is reversed and the chitin is pumped out thorugh inlet / outlet 8 of the inner tank.

The examples above should merely be regarded as examples of how the process tank may be utilized. The scope of the invention is limited only by the following claims.